Real-time and remote monitoring of sediment and sewage contamination in the Tijuana River and Estuary

San Diego Estuaries Research Symposium February 7, 2023

Trent Biggs
Natalie Mladenov
Pablo Bryant
Dan Sousa

Doug Liden
Yongping Yuan

Jeff Crooks

Omar Zurita

Student team
Field Lead: Stephany Garcia
Lab Leads: Keyshawn Ford, Elisa Rivera

Callie Summerlin, Ben Downing
Isaiah Hand, Emily Deardorff
Elena Aguilar, Adolfo Lopez-Miranda

Funding

J. W. Sefton Foundation
Family foundations

EPA

NASA

SDSU

NOAA-CESSRST
CENTER FOR EARTH SYSTEM SCIENCES AND REMOTE SENSING TECHNOLOGIES

Motivation: Sediment loads and sewage contamination are problems…

…but TJRiver {esp. stormflow} not sampled regularly since ~2014

…and never continuously or in real-time

Contaminated water signs posted along the southern part of the Imperial Beach in 2019. (Alejandro Tar
Diego Union Tribune)

Problem: Samples are time consuming and expensive to collect and analyze

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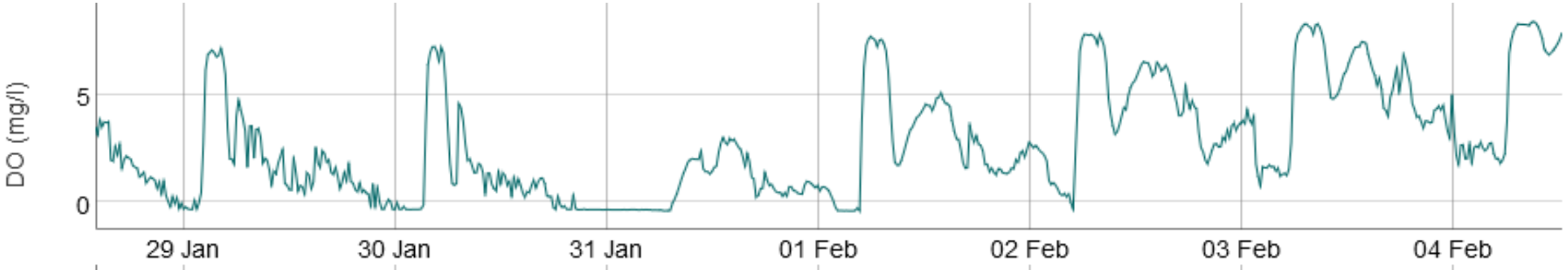
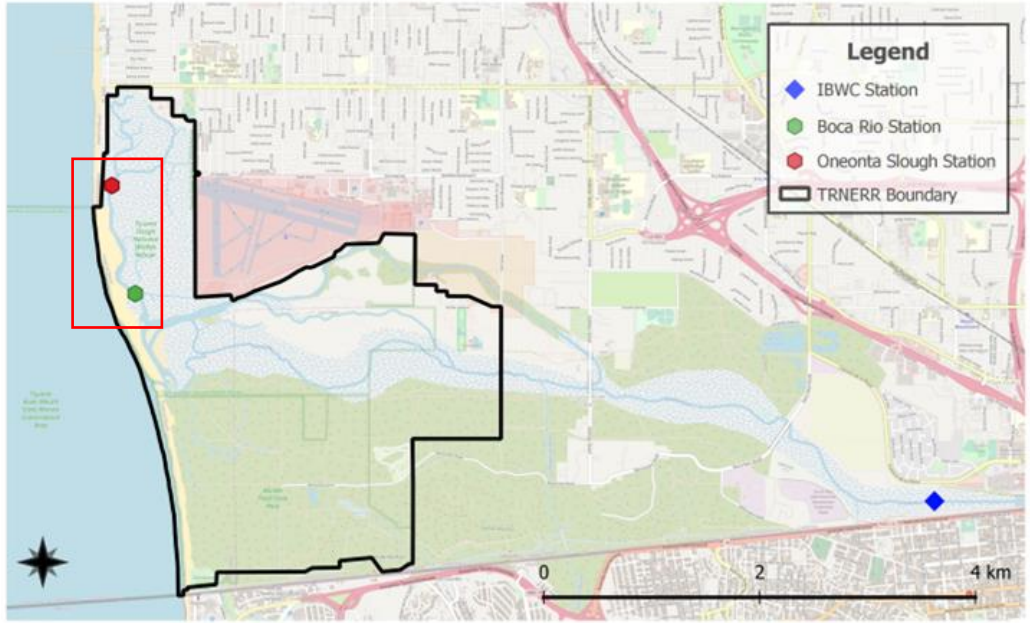
TJ Estuary WQ monitored in real-time (DO, salinity, turbidity, {CDOM})…





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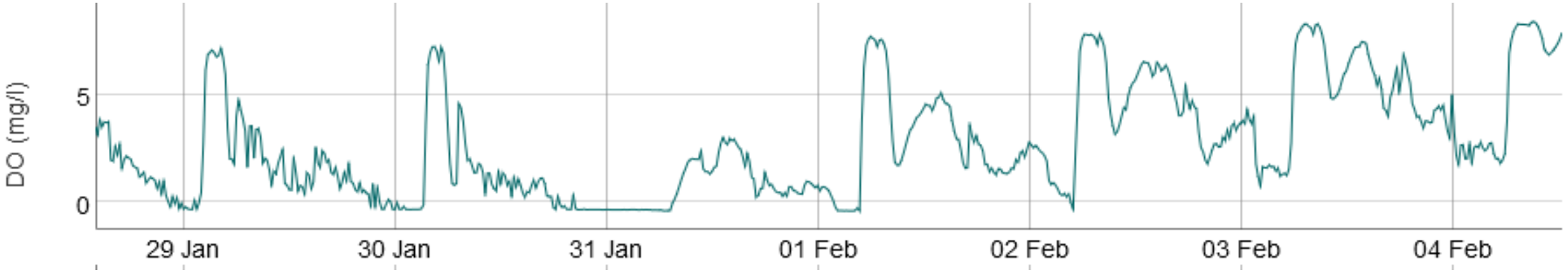
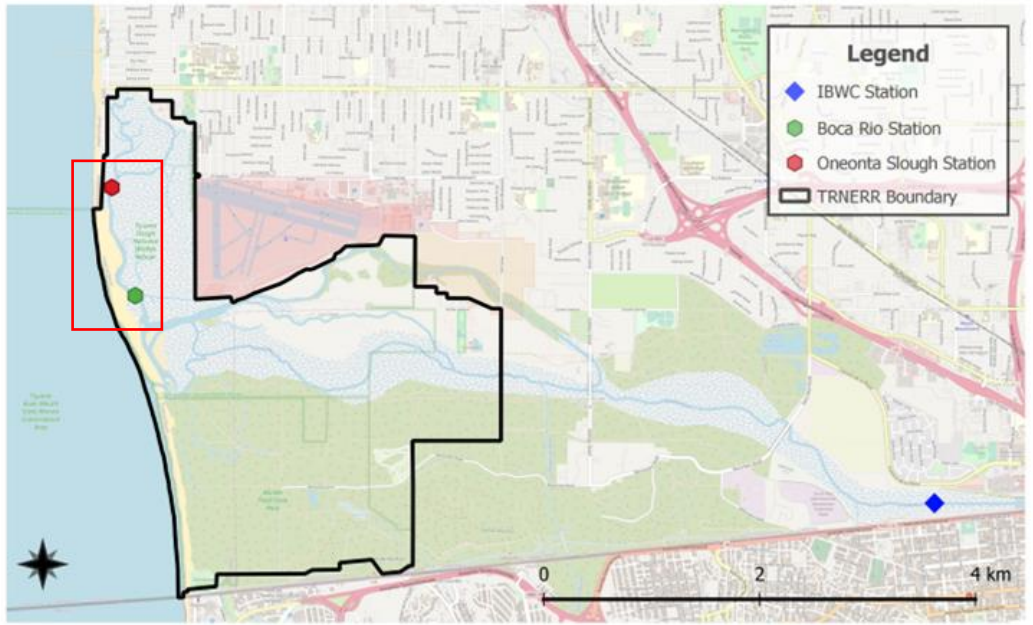


How estimate sediment, bacteria concentrations over space and time?



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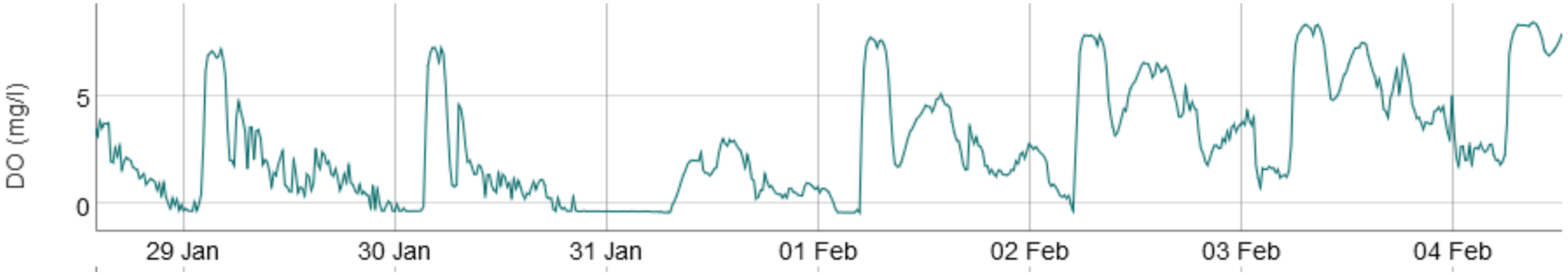

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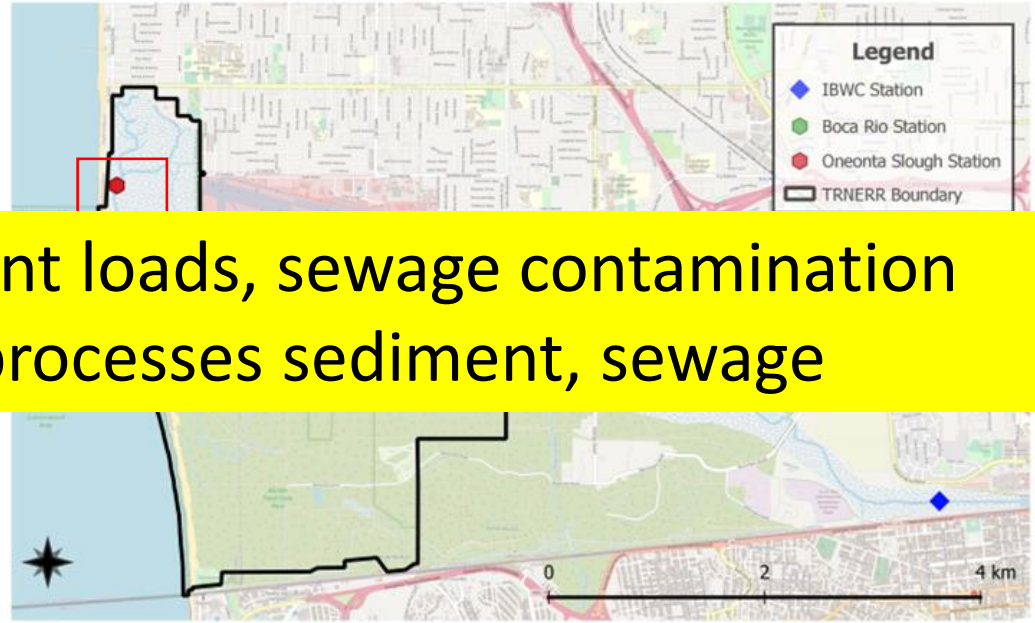

Goals: 1) real-time information about sediment loads, sewage contamination
2) Understand how the estuary retains, processes sediment, sewage

Opportunity 1: Fluorescence → ww, bacteria

- Tryptophan-like—sewage and bacteria proxy
- CDOM (chromophoric dissolved organic matter)

+ telemetry = Real-time!

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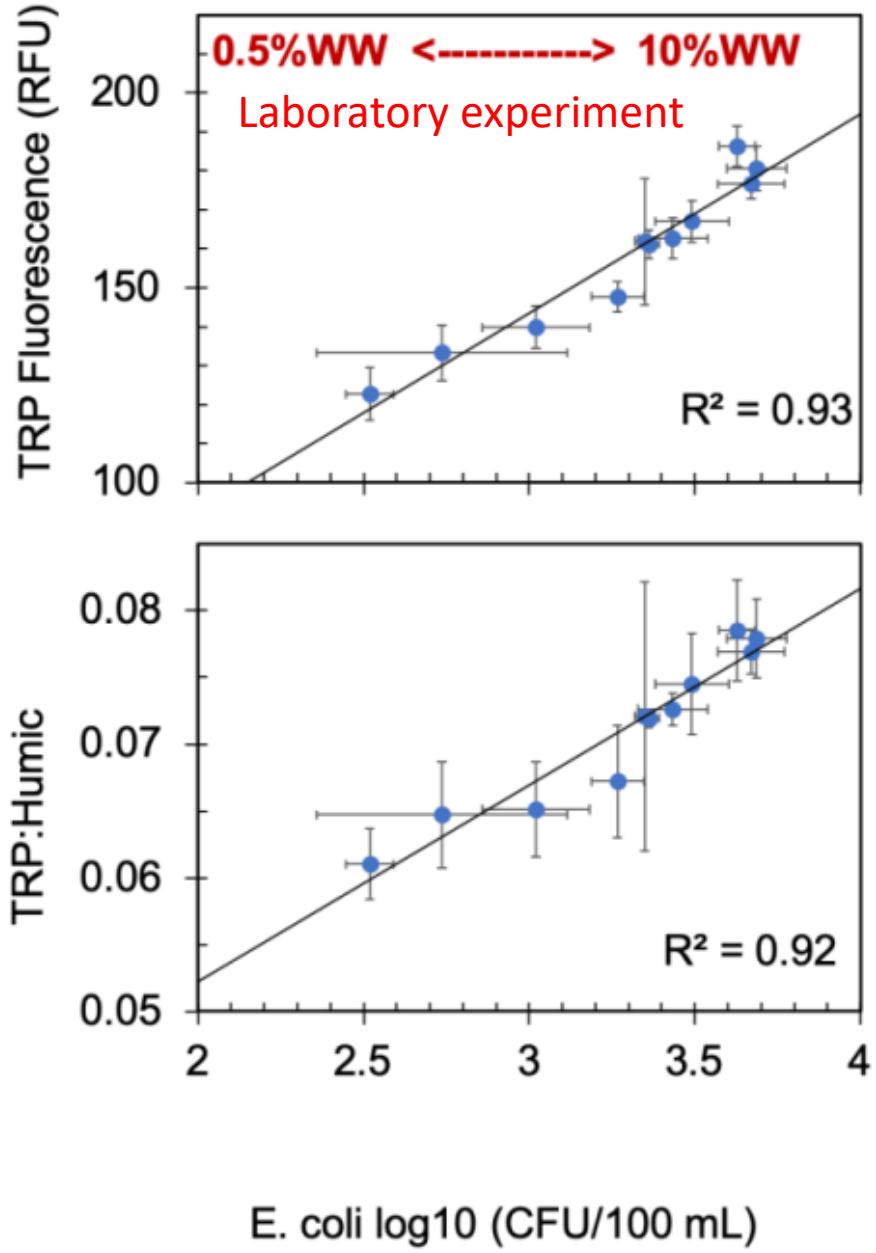


Mendoza et al, 2020

Opportunity 2: Remote sensing

Near-surface hyperspectral

- Continuous
- No cloud issues
- Lots of EM bands

Satellite-based

Planet	Sentinel
Daily	5 day
3m	10 m res

Research questions

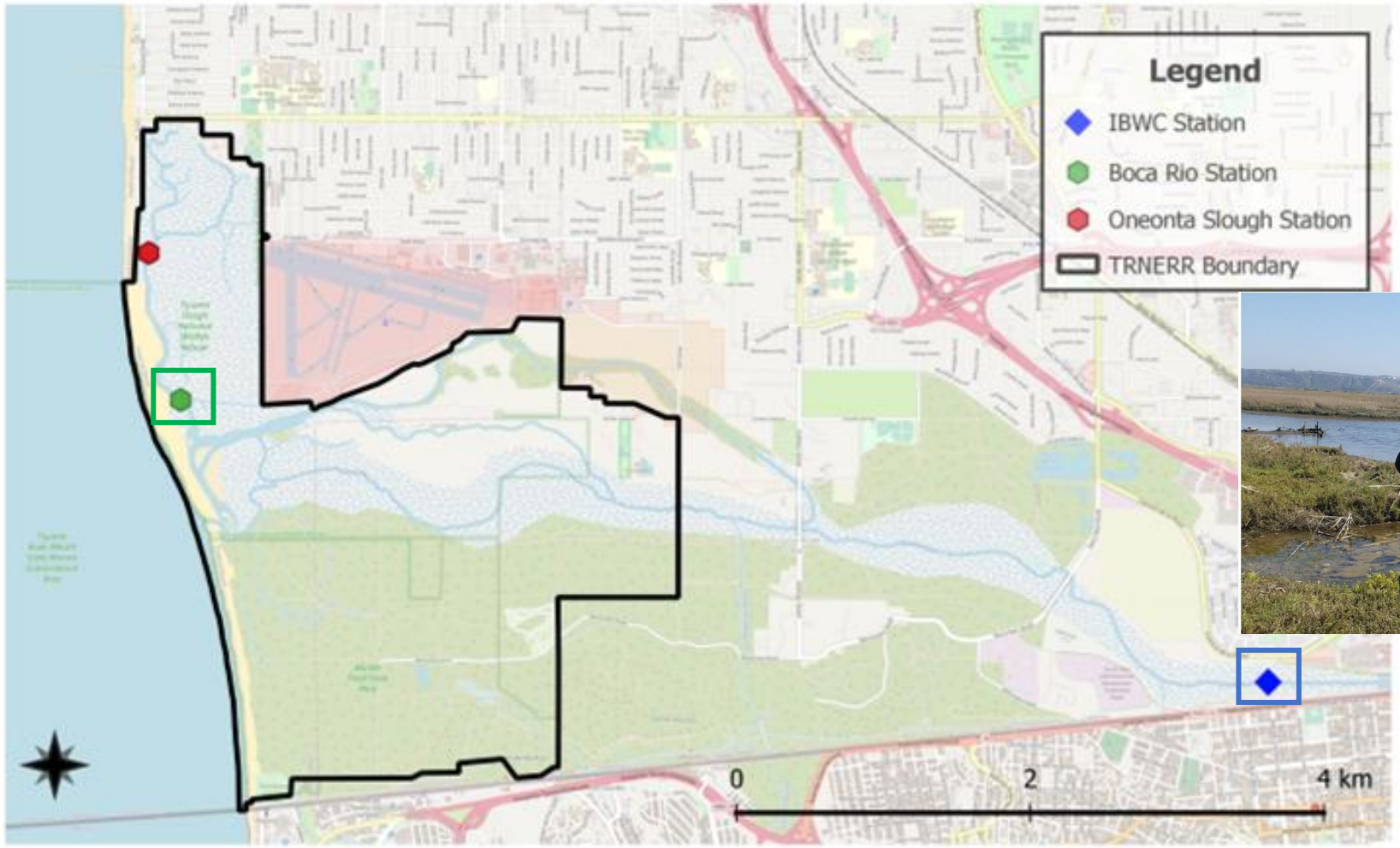
1. How accurate is *in situ* proxy sensing of bacteria?

2. How can remote sensing supplement in situ sensors to map contamination?

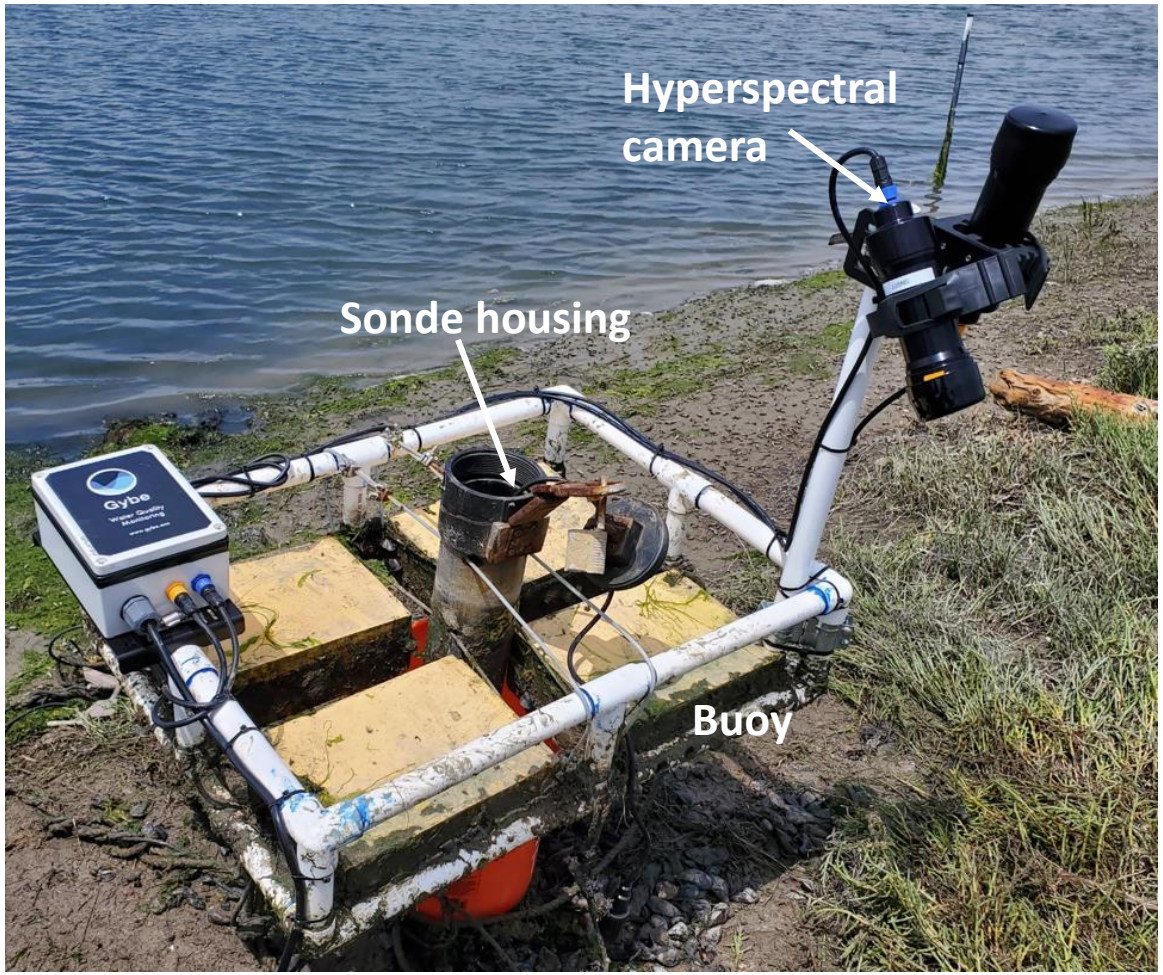
3. What are the spatial and temporal patterns of sediment and sewage contamination in the TJRiver and Estuary?

Methods: N=2 *in situ* sensors

Manta 3: temp, pH, cond, DO, turbidity, TRYP, CDOM



Boca Rio station



IBWC station

Real-time data! IBWC site @ wqdatalive.com

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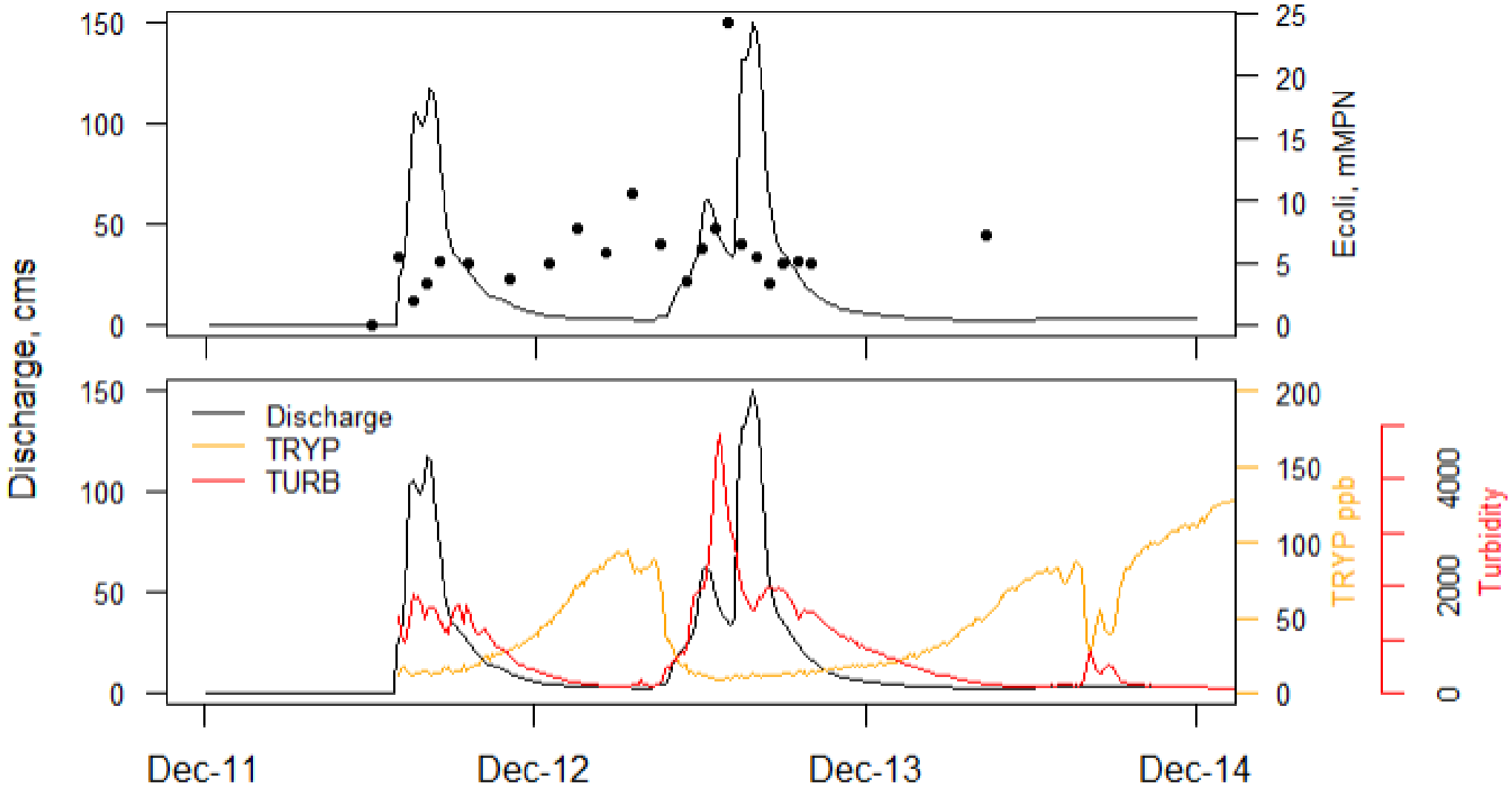
IBWC Station Storm Event, Dec 2022

[Ecoli], TRYP high @ low flow, diluted @ (most) high flows



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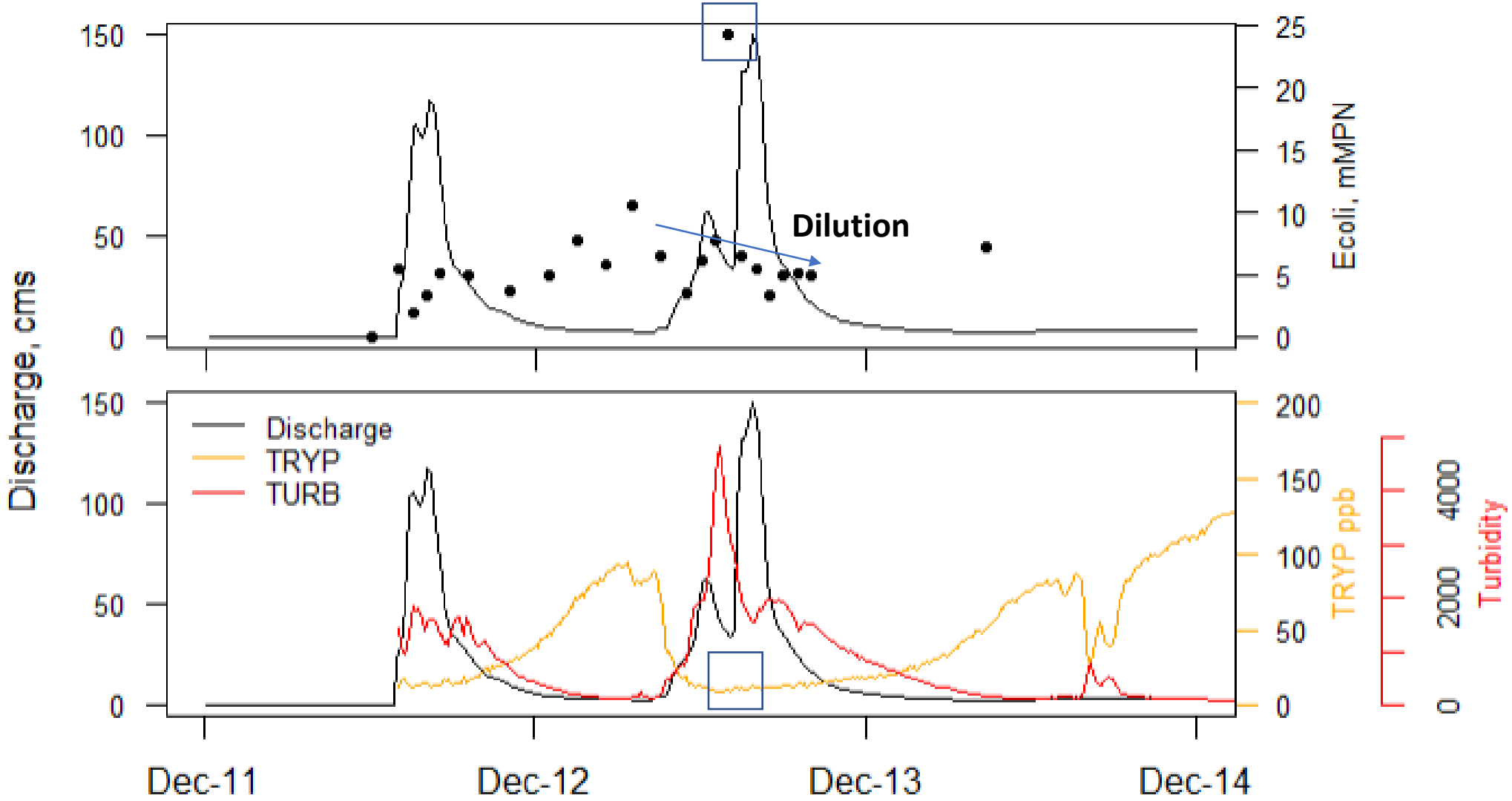
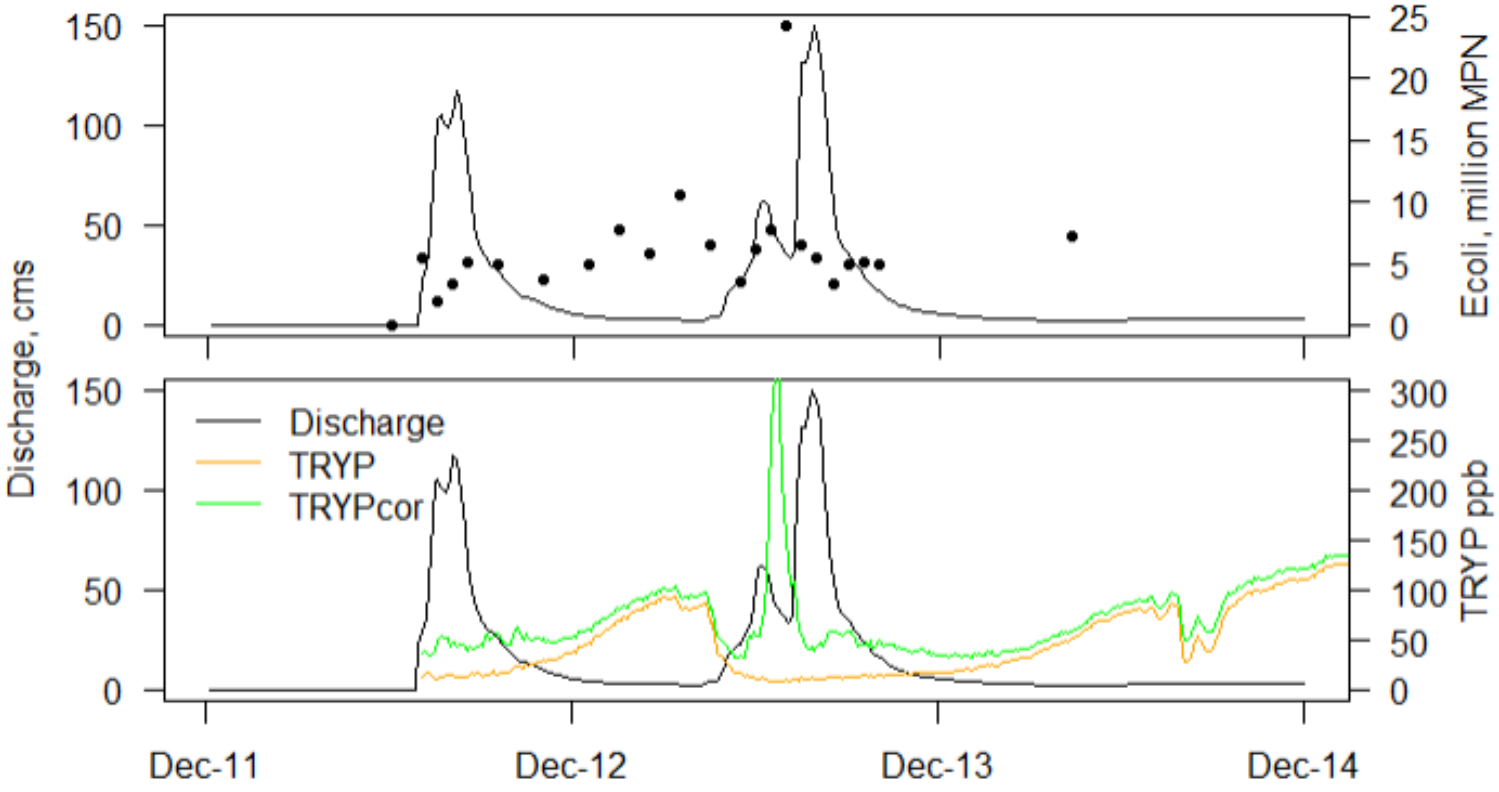


Turbidity correction factor = e^{-kTURB}



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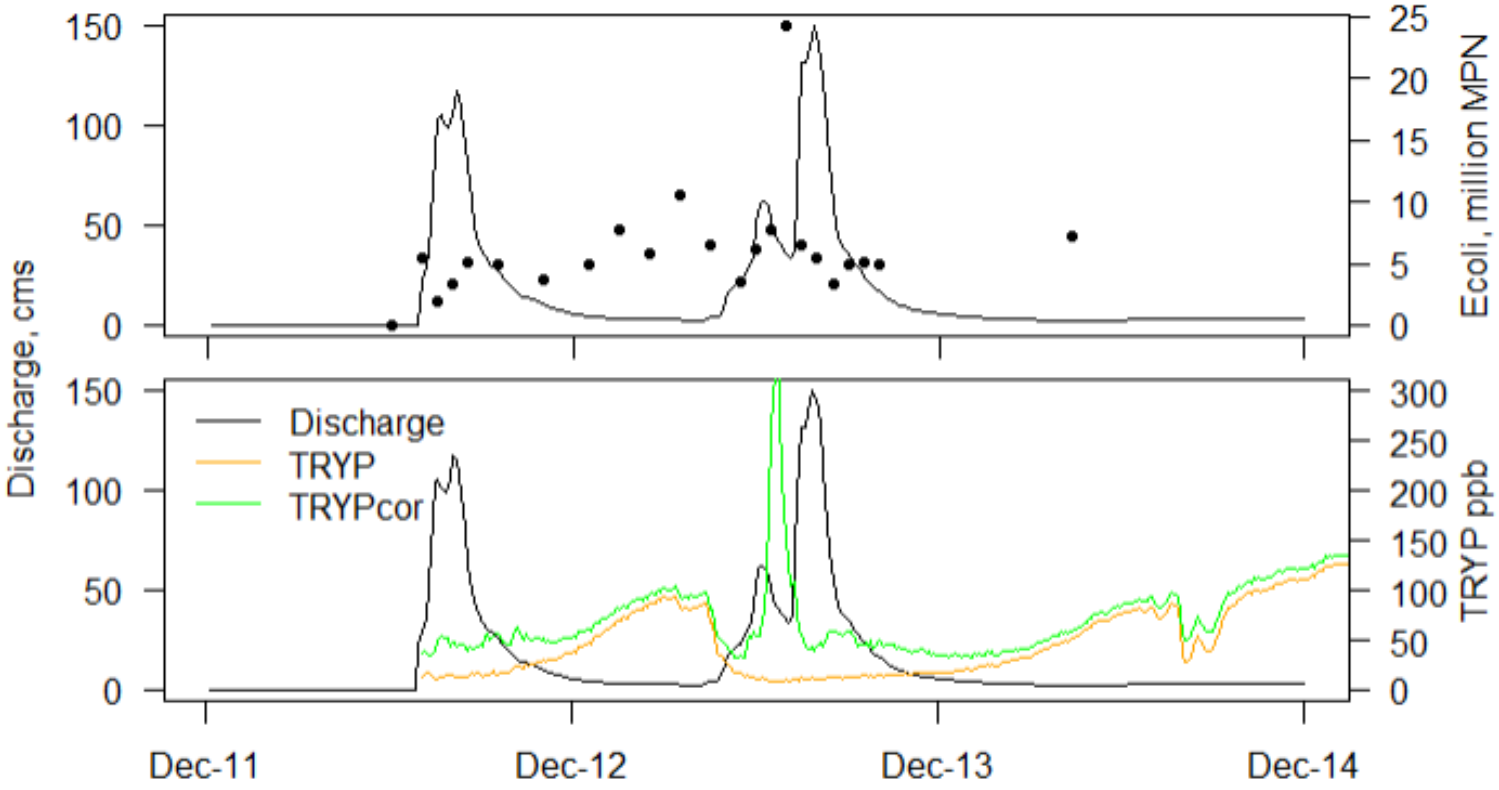

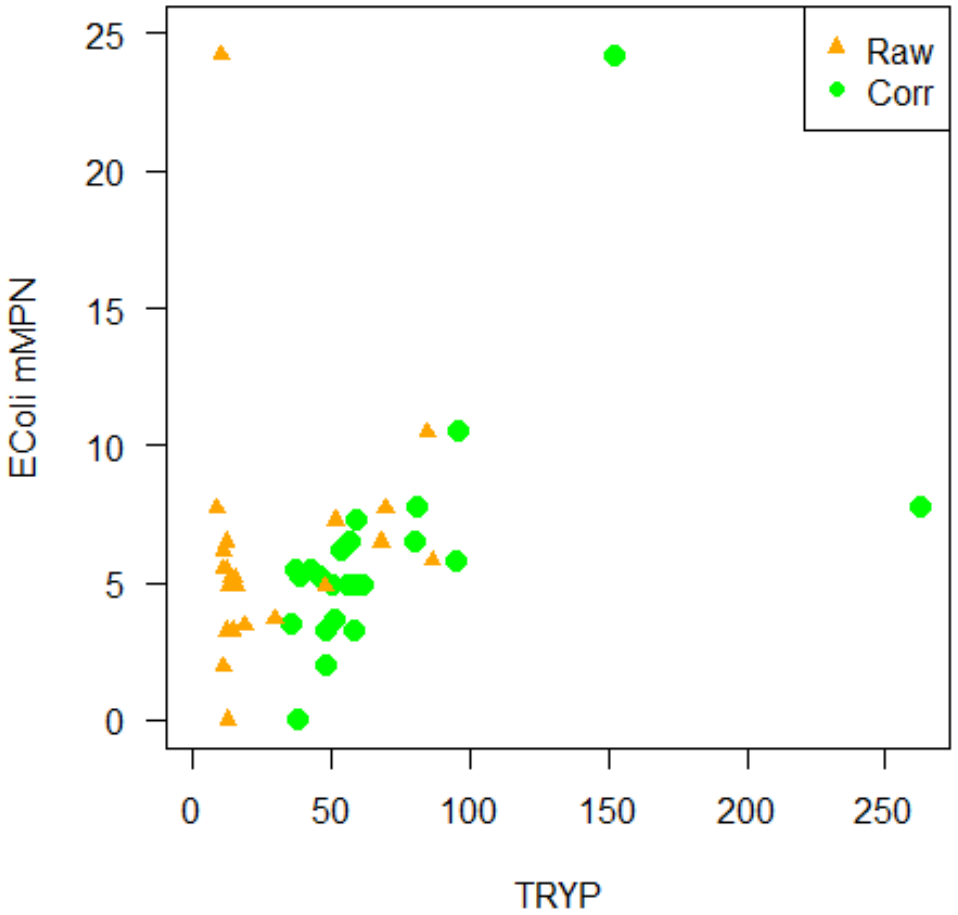

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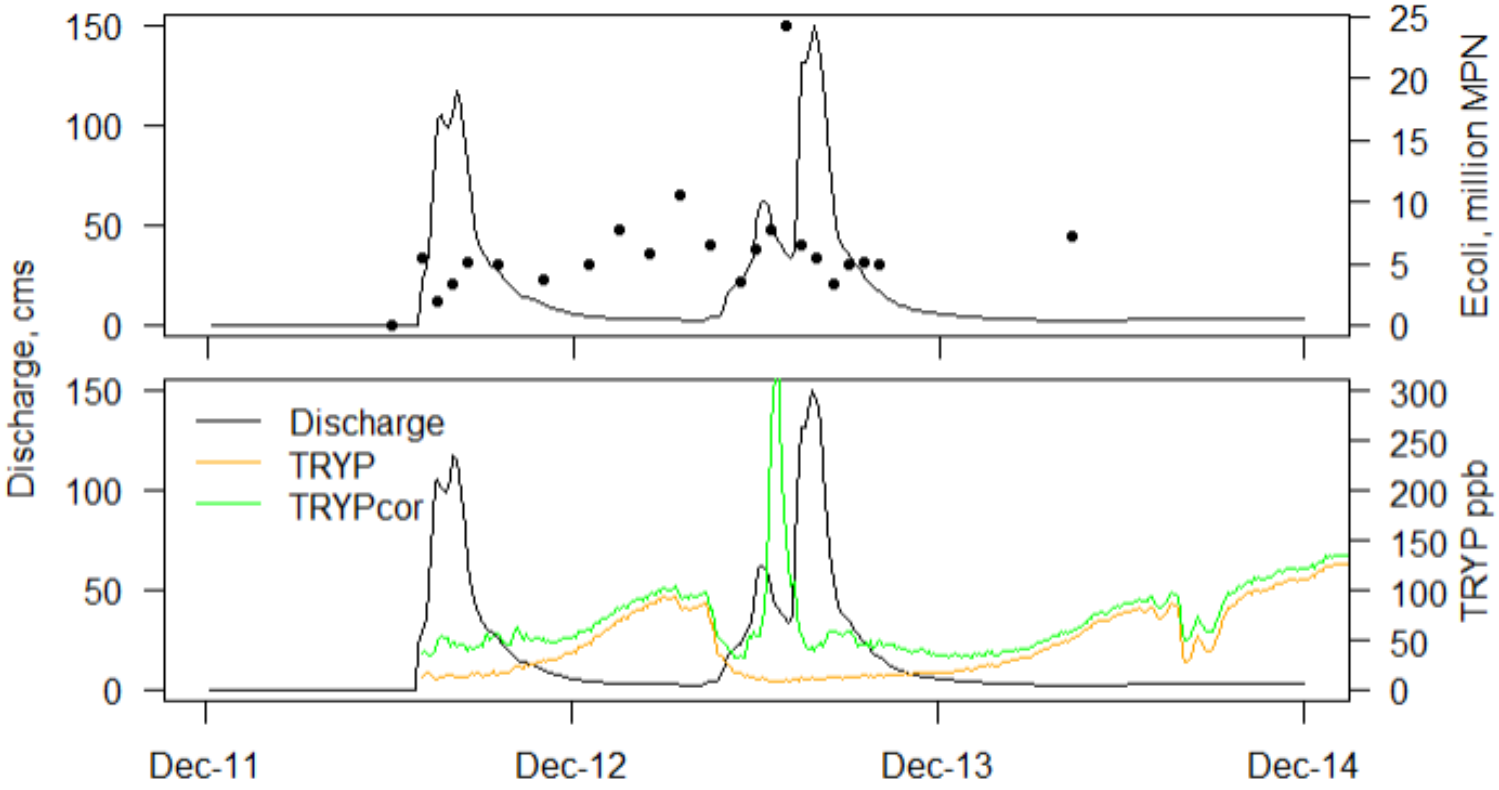
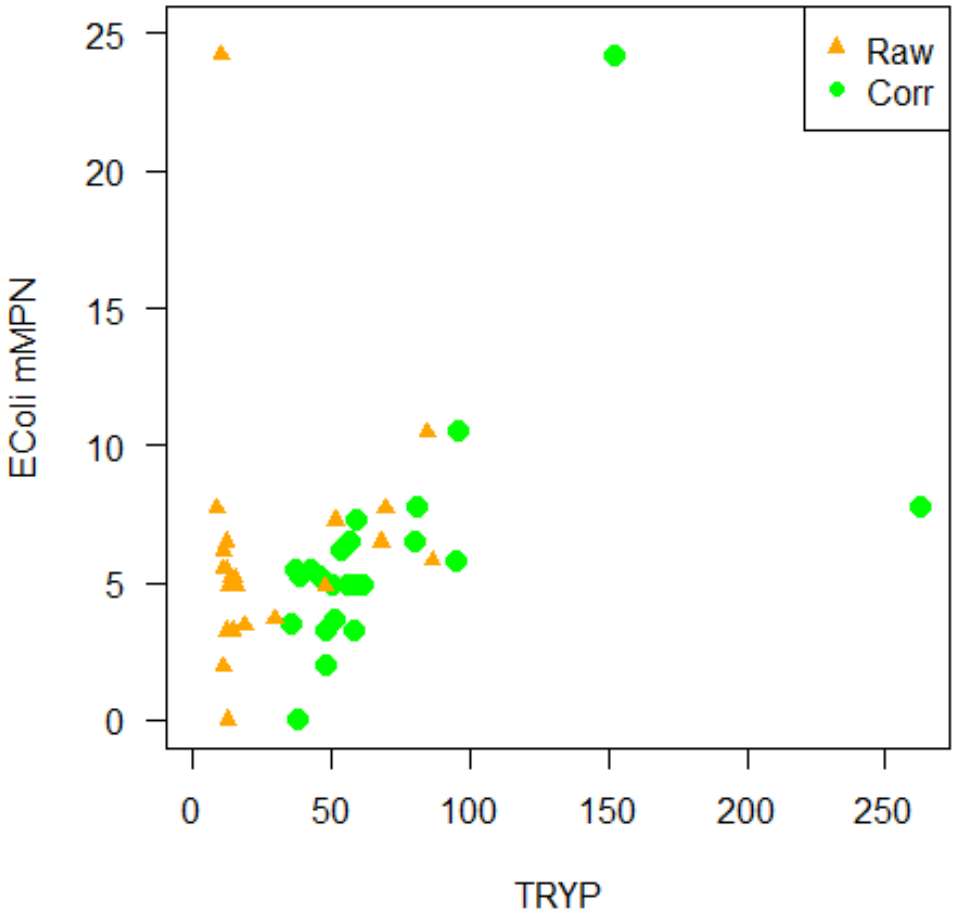
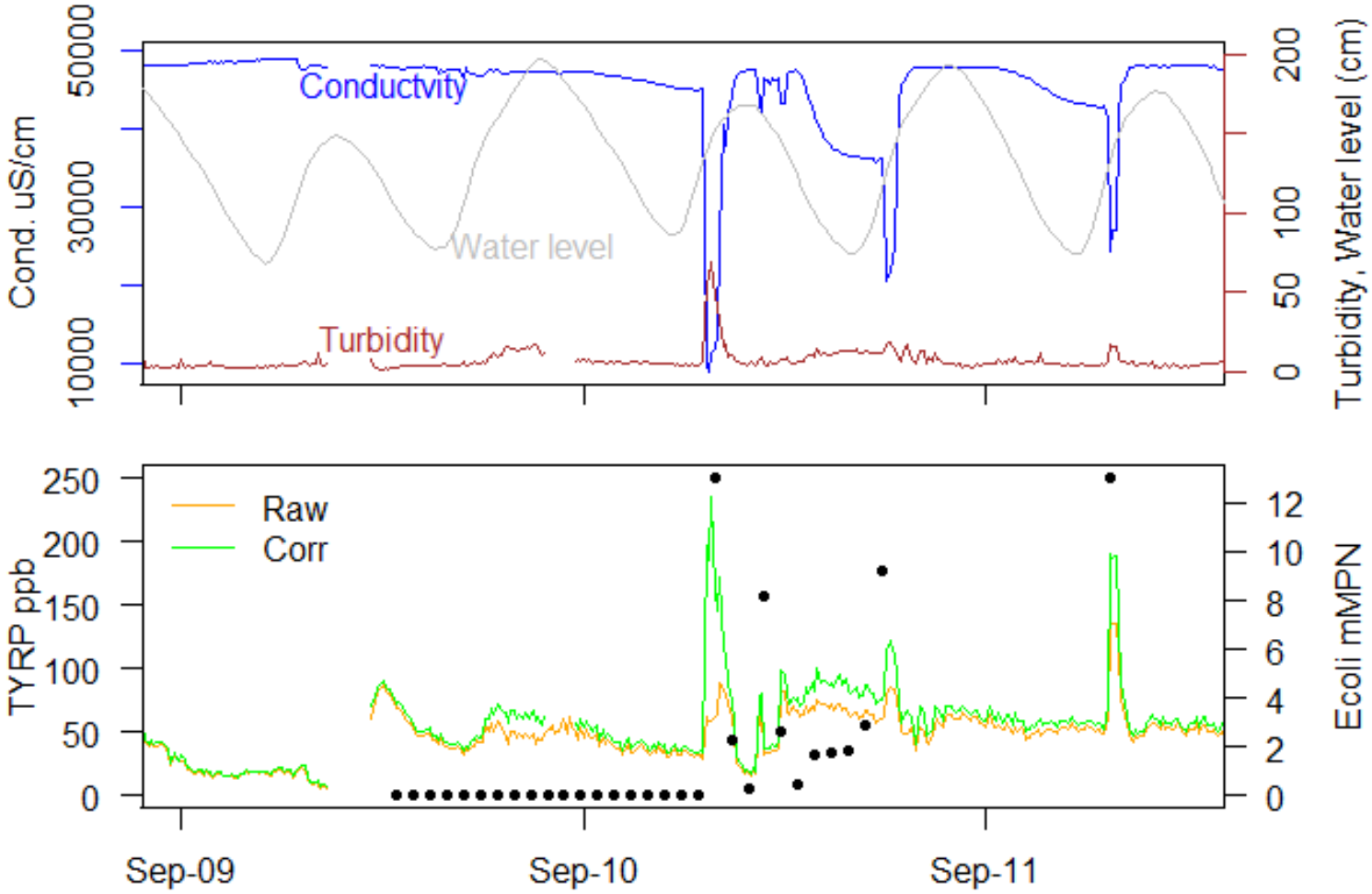




Is k constant over space and time?

Boca Rio site (estuary)

Sept 2022 Storm Event



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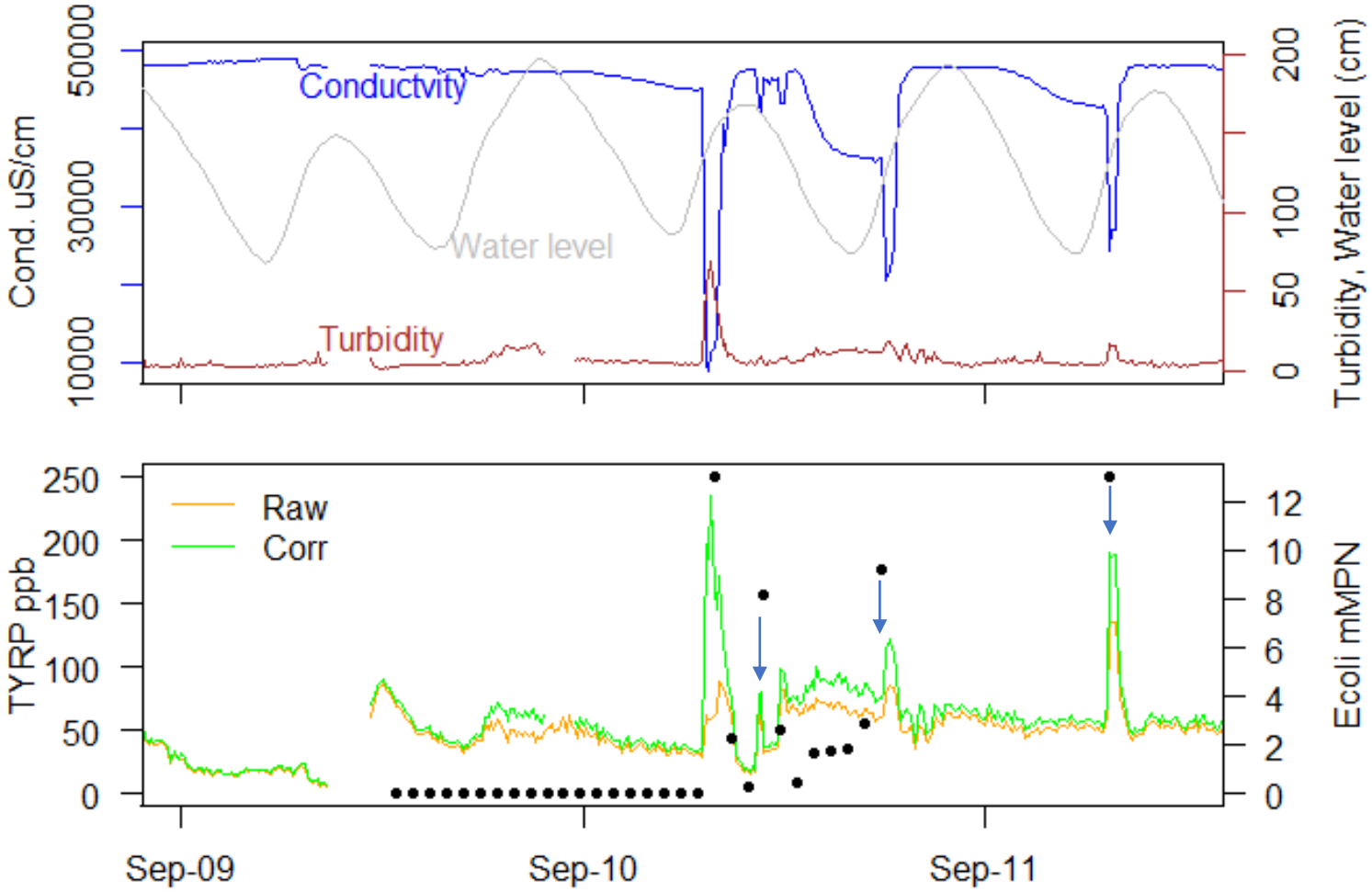

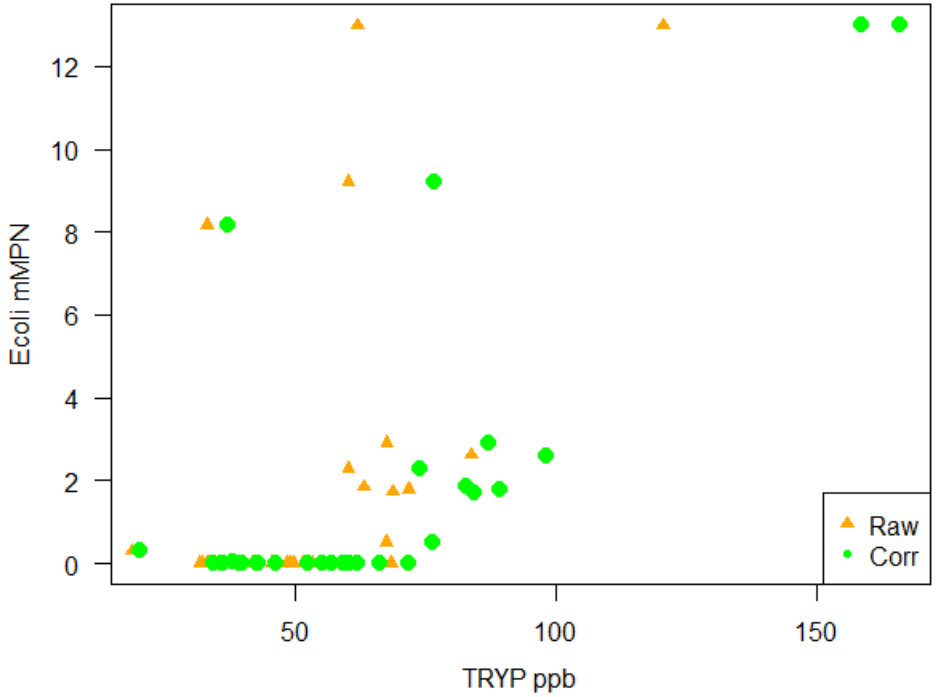

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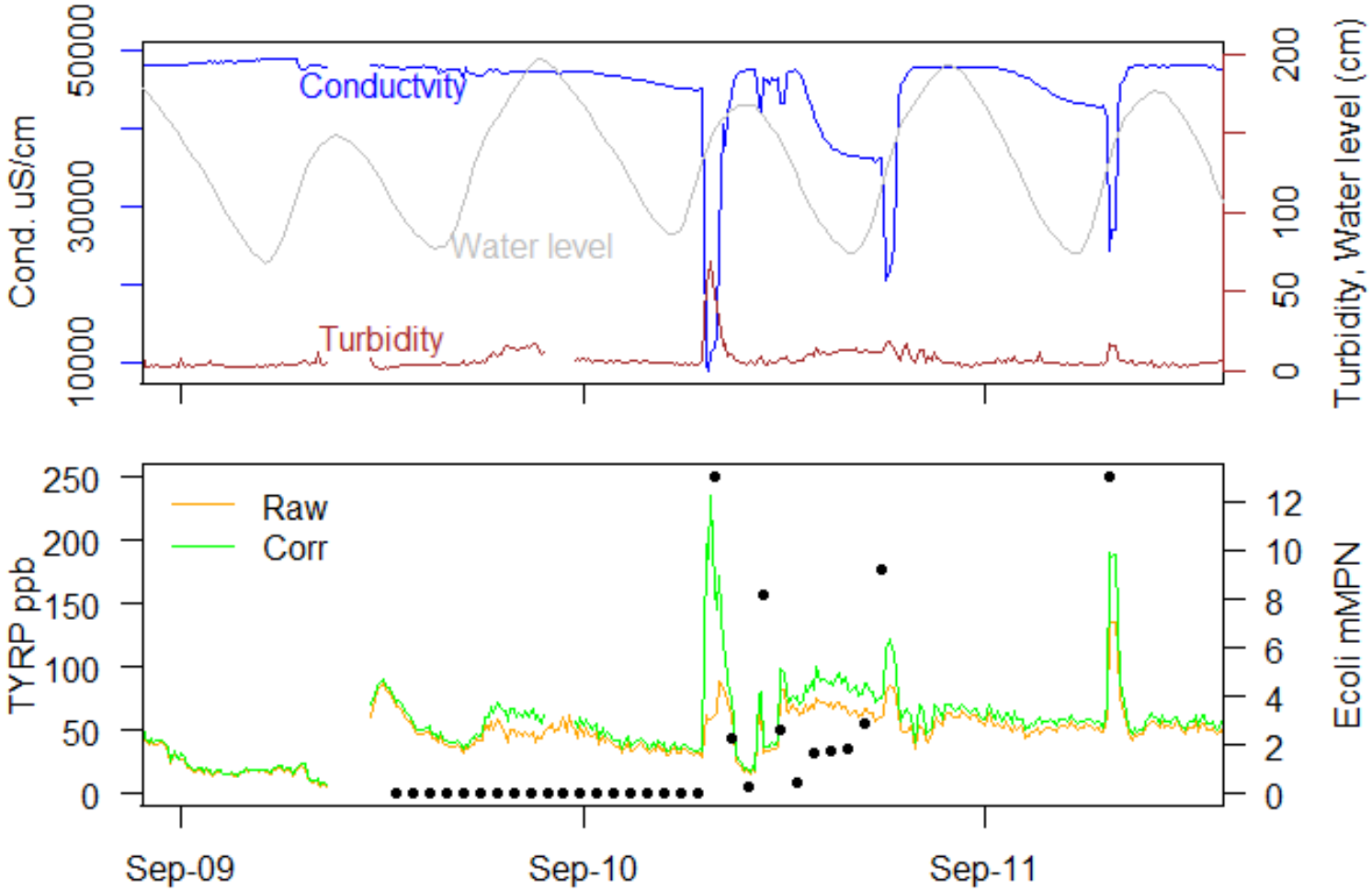

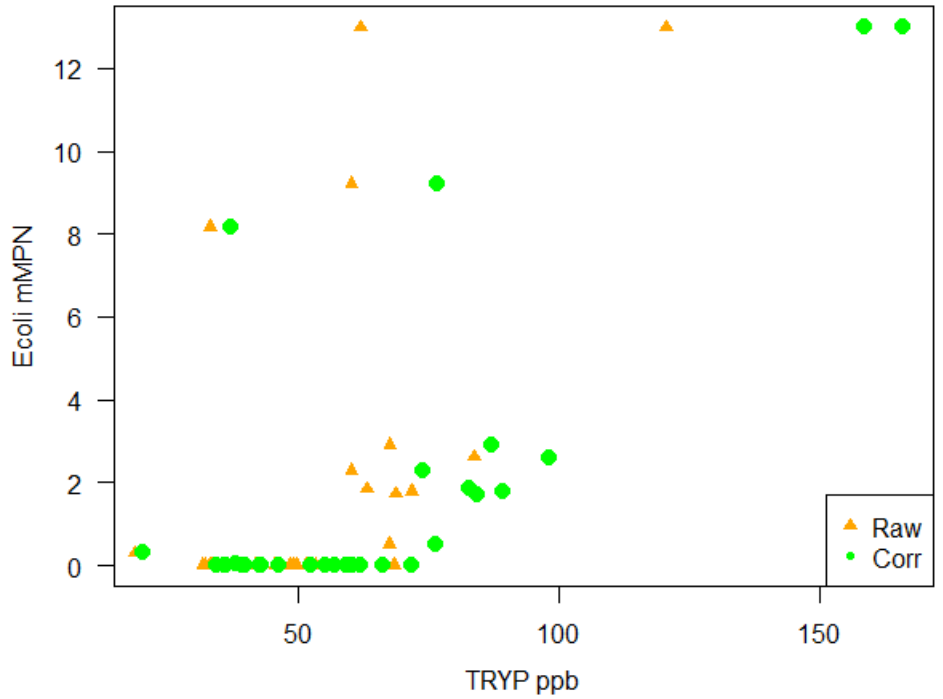

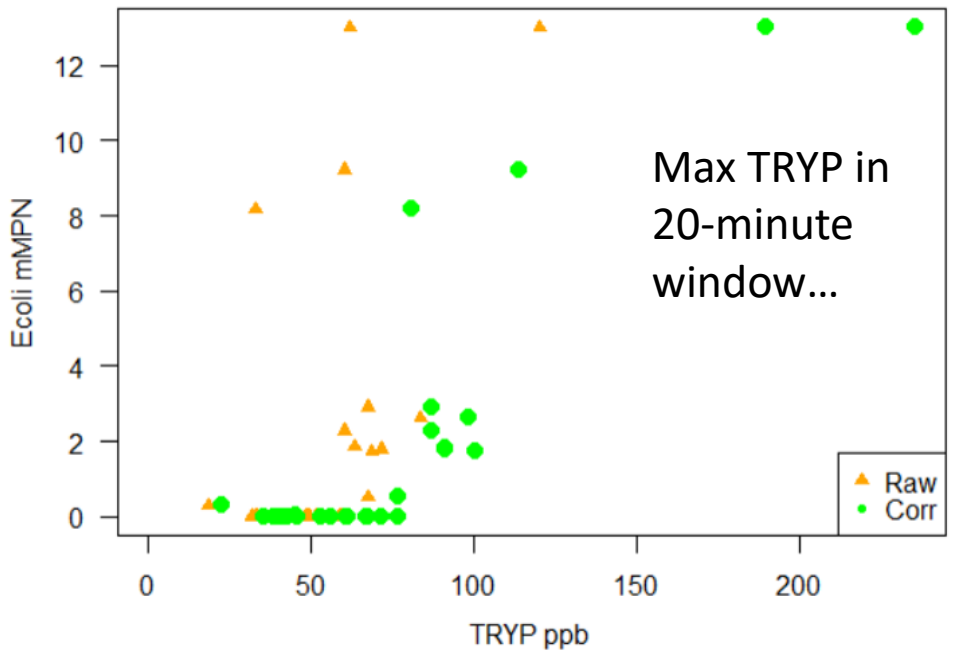

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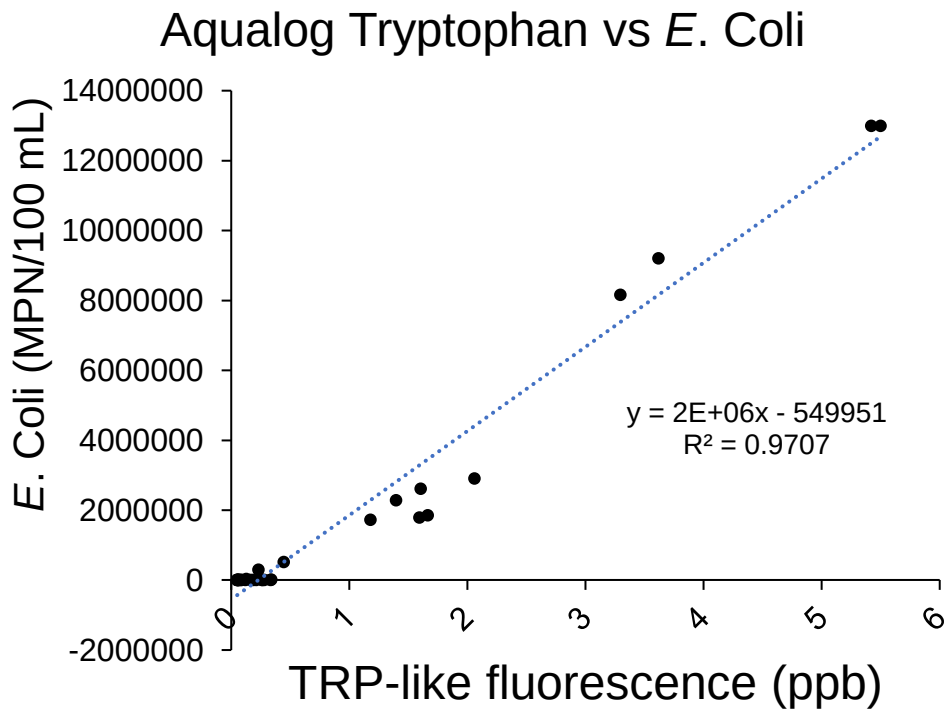
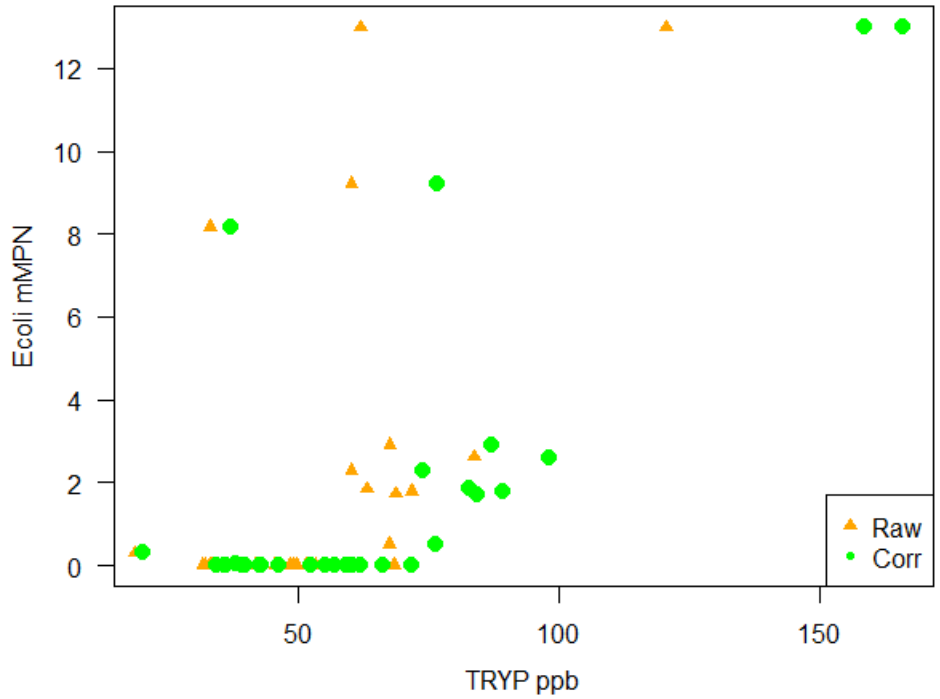
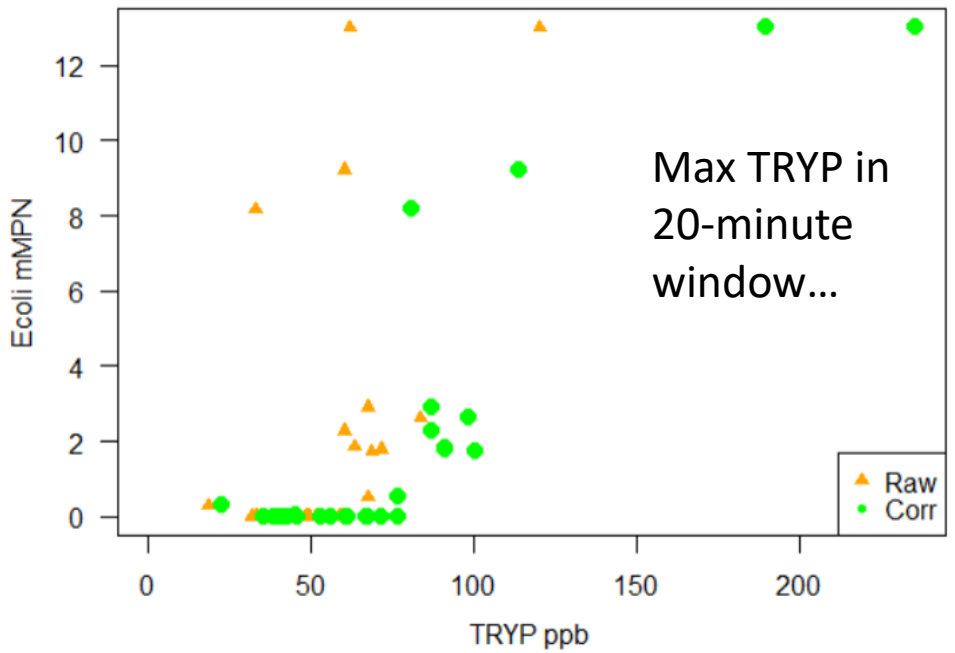
Sept 2022 Storm Event

But lab-based TYRP (Aqualog)
on filtered sample: Great!







What else might be interfering with field-based TRYP?
Turbulence? Particle size?

Challenges

Fouling by sediment, organisms…

Frequent maintenance (2-4x month)

Sensor degradation / instability / replacement

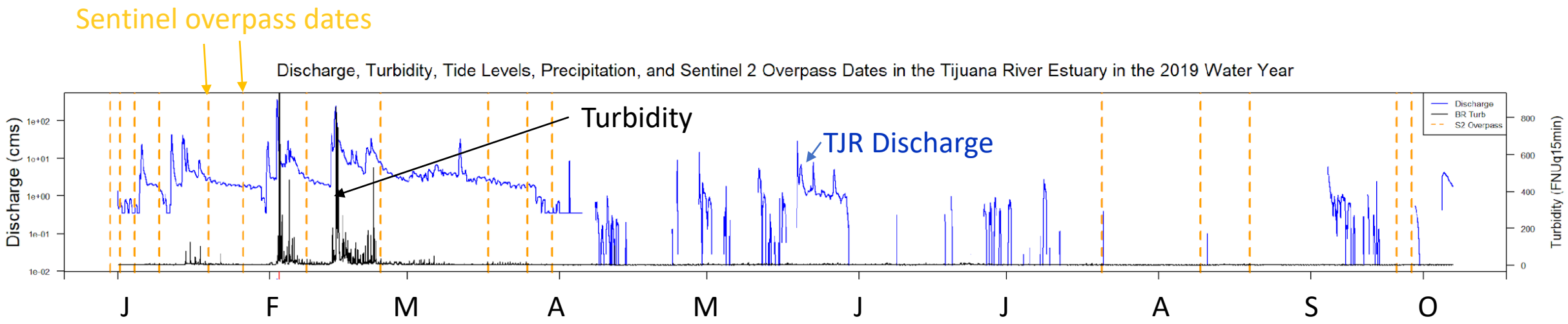
Special calibration standards (sulfuric acid)

Staff time, training, sustained funding

2. How can remote sensing supplement in situ sensors to map contamination?

Google Earth Engine of Ayad et al, 2020
Sentinel-2: 5 day, 10m

Good temporal coverage
…but during storms?



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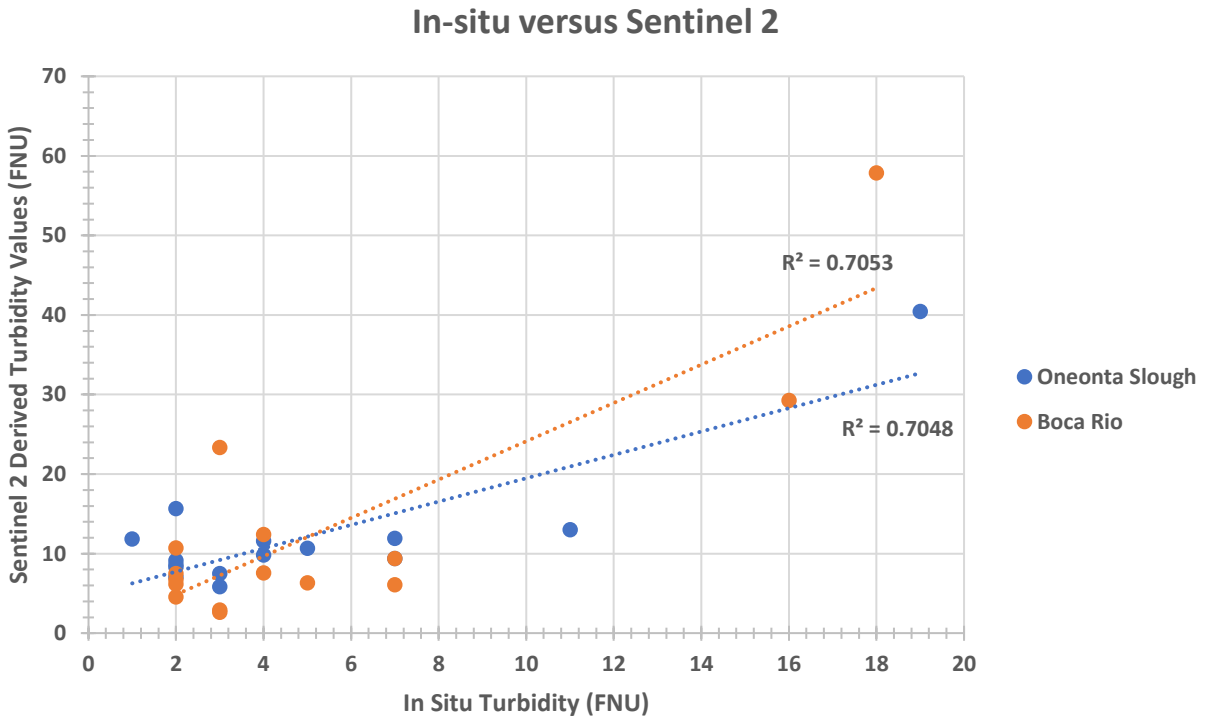
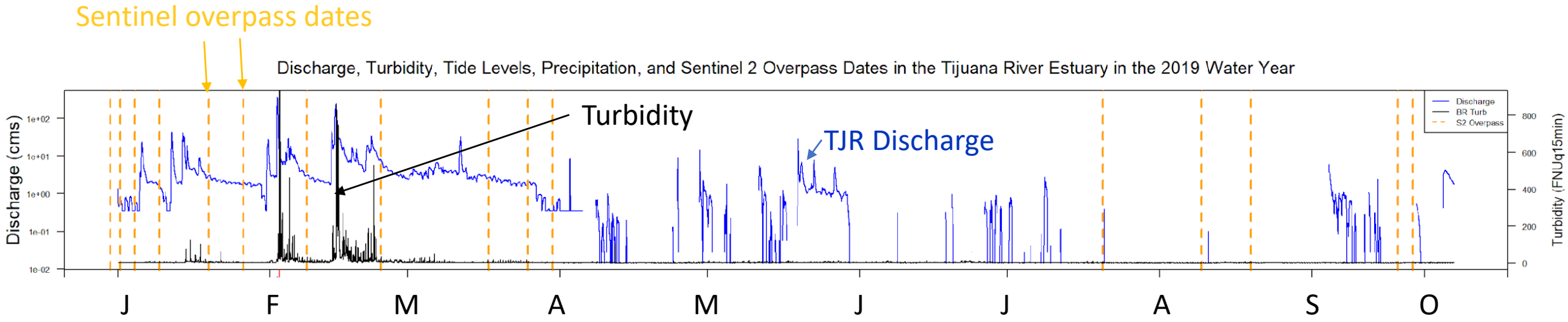
Good correlation (for low turbidity)…





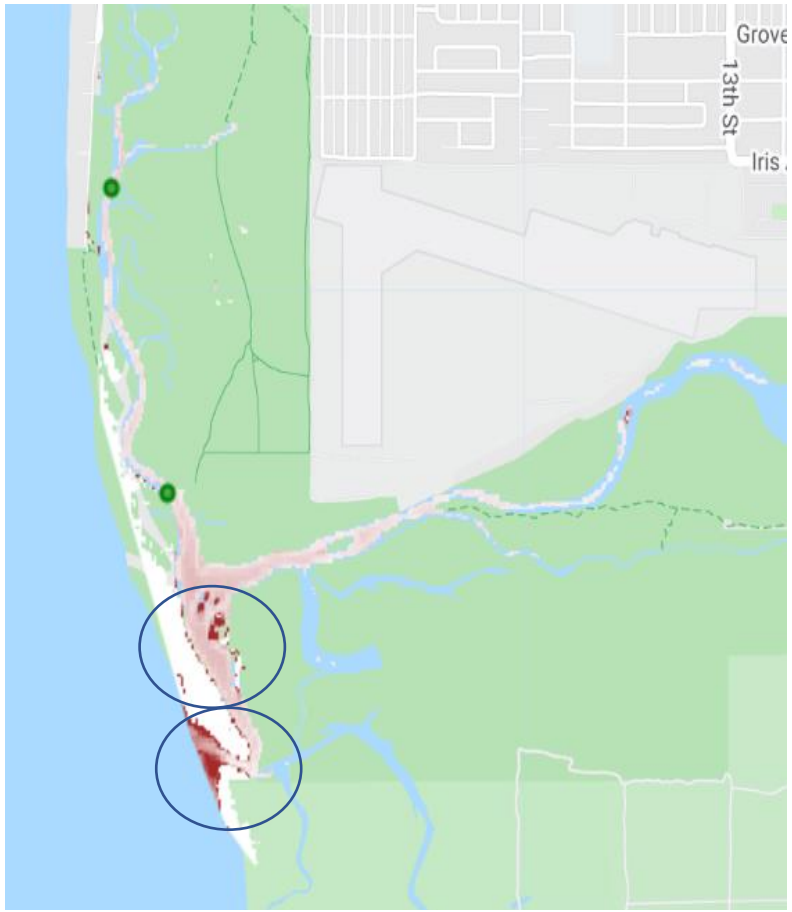
Turbidity hotspots: Near mouth (?), main channel

Effect of tides, storms, water depth (bottom reflectance)?

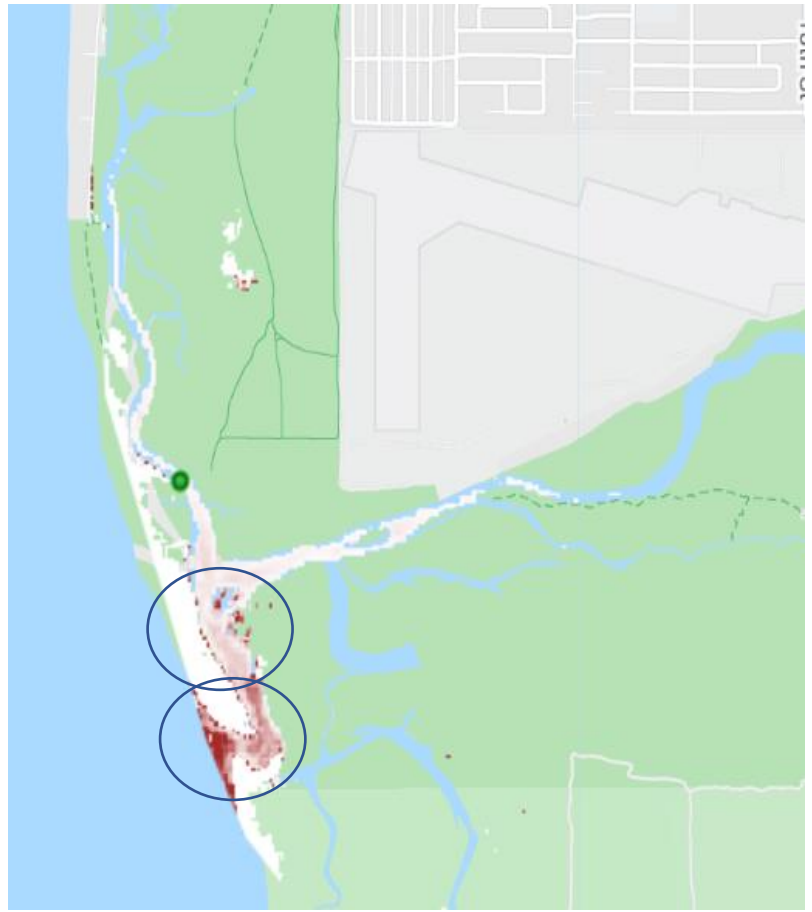
How validate? Can't kayak during/after storm, sewage for safety…

Jan 9, 2019

Feb 23



Aug 19



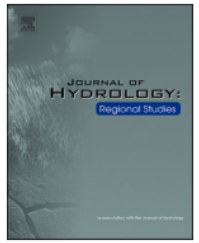
Long-term goals

- Real-time warning system—air pollution, why not water? Funding?
  → Hyperspectral, ground-based cameras
- Map hotspots and hot moments of pollution in the estuary and near-coast
- Sediment and bacteria budget of the estuary—monitor outlet
  How much sediment and pollution does the estuary retain?

Contents lists available at ScienceDirect

Journal of Hydrology: Regional Studies

journal homepage: www.elsevier.com/locate/ejrh



Runoff and sediment loads in the Tijuana River: Dam effects, extreme events, and change during urbanization

Trent Biggs [a,*], Adam Zeigler [a], Kristine T. Taniguchi-Quan [b]

[a] Department of Geography, San Diego State University, San Diego, CA, USA
[b] Southern California Coastal Water Research Project, 3535 Harbor Blvd Suite 110, Costa Mesa, CA 92626, USA

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Thank you!

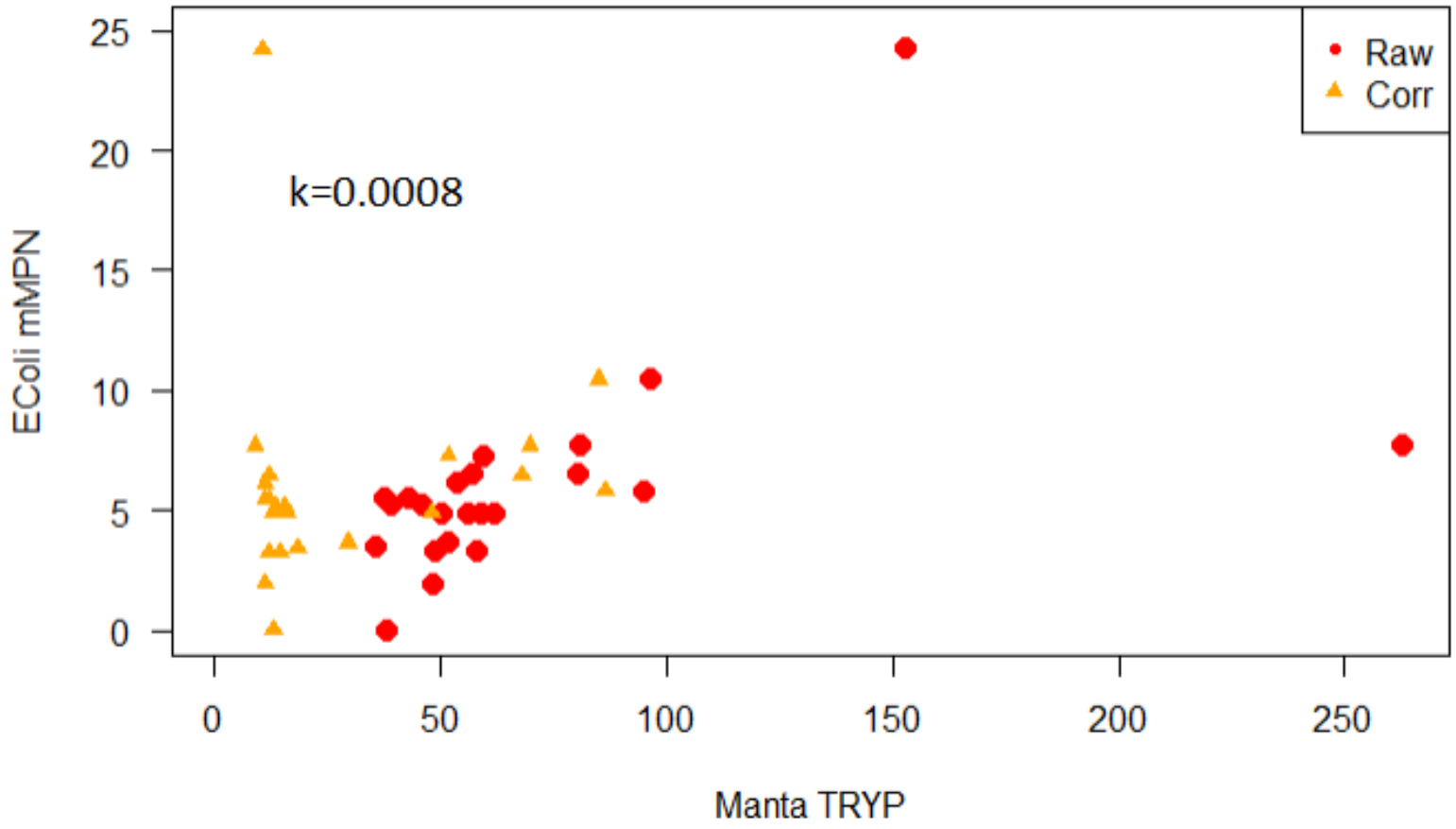
https://biggslab.sdsu.edu/

https://mladenov.weebly.com/

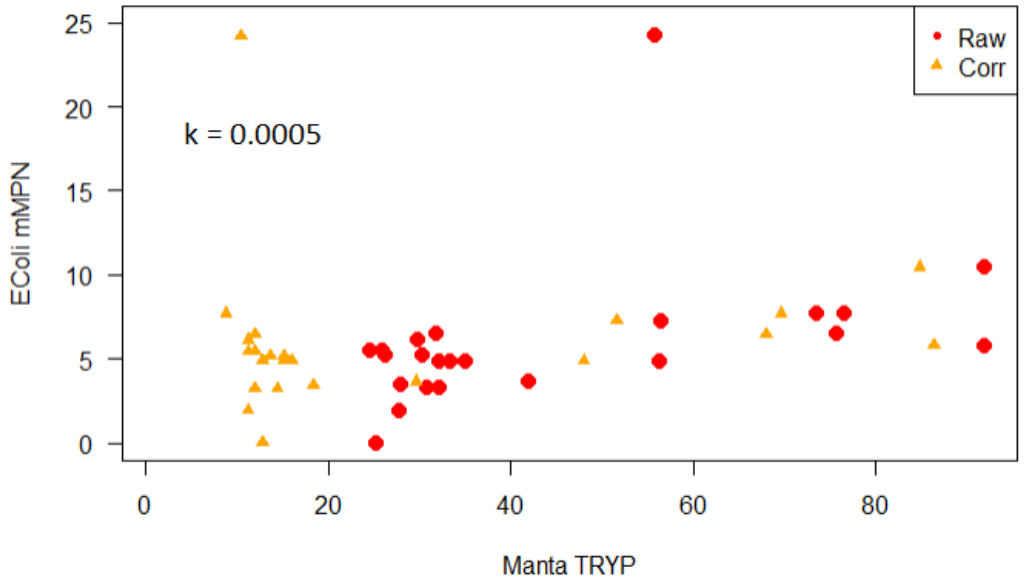
https://www.gybe.eco/

Turbidity correction is necessary…sufficient?

Constant among events?



K= -0.0007


k = 0.0005
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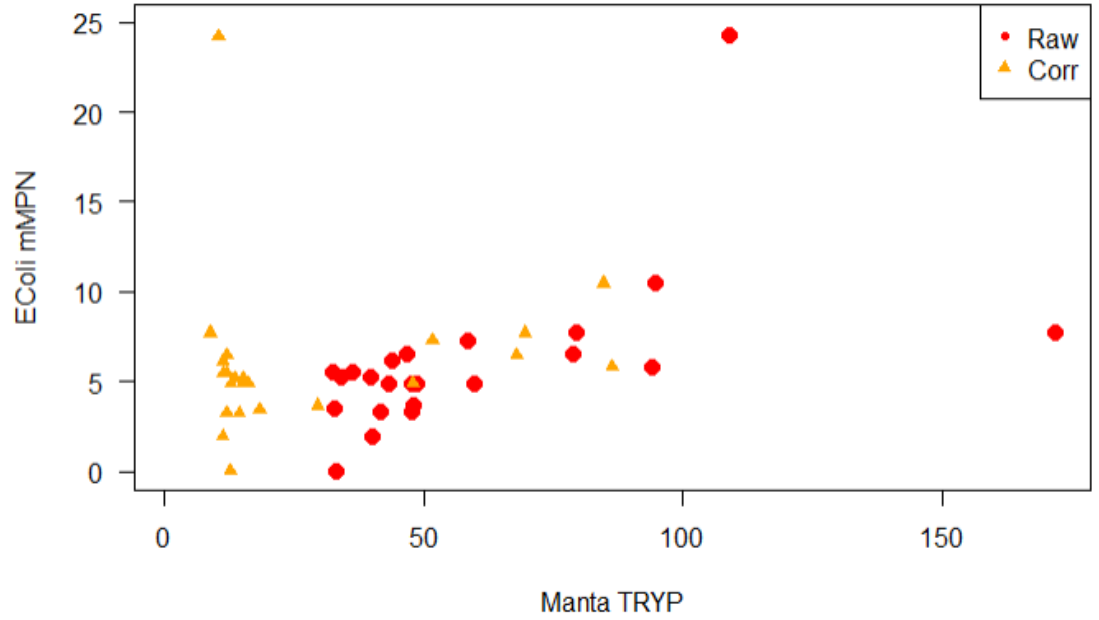
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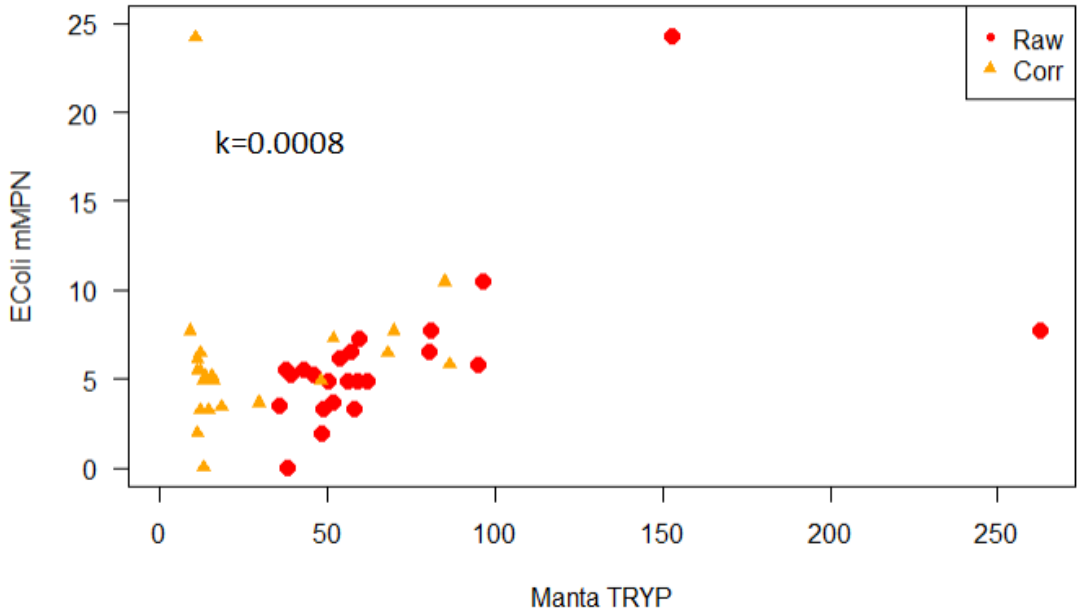
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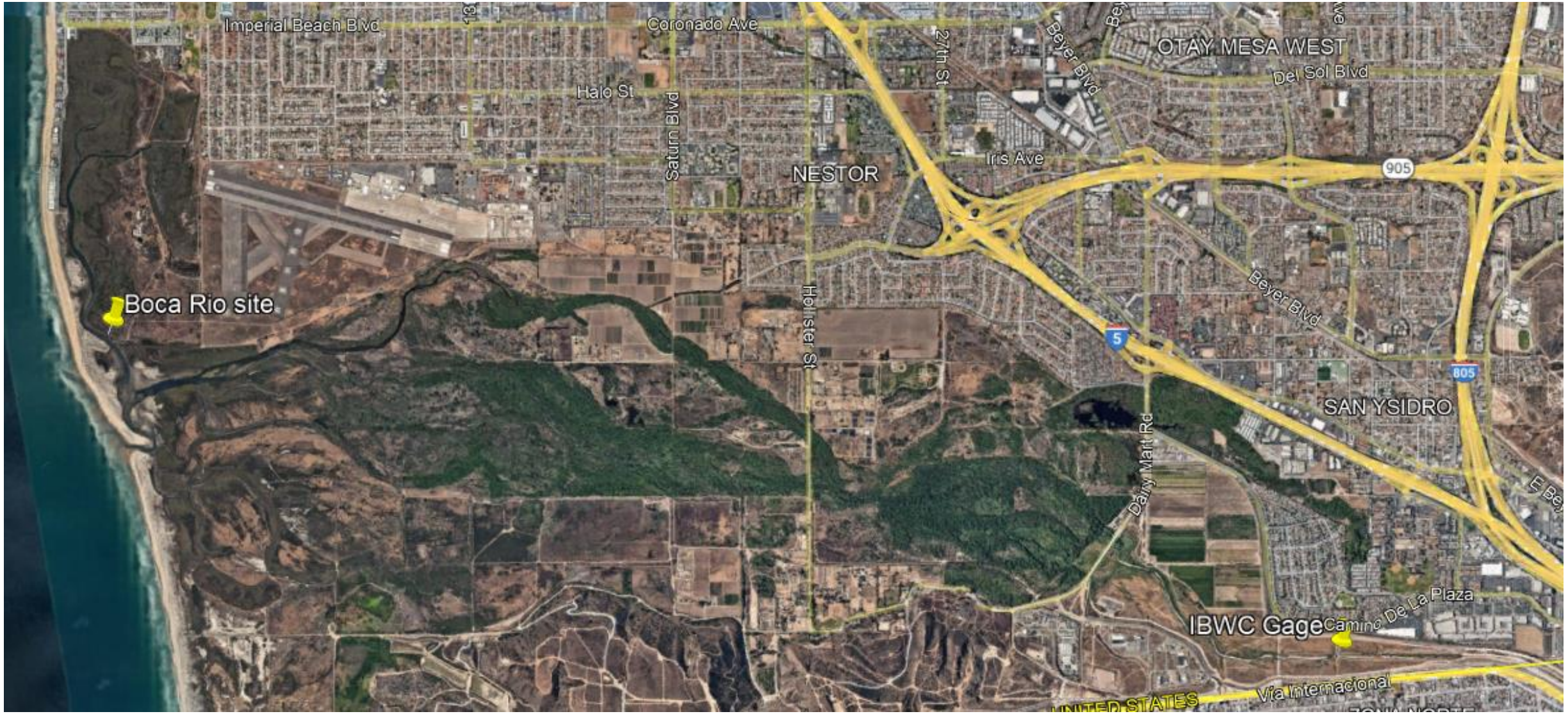
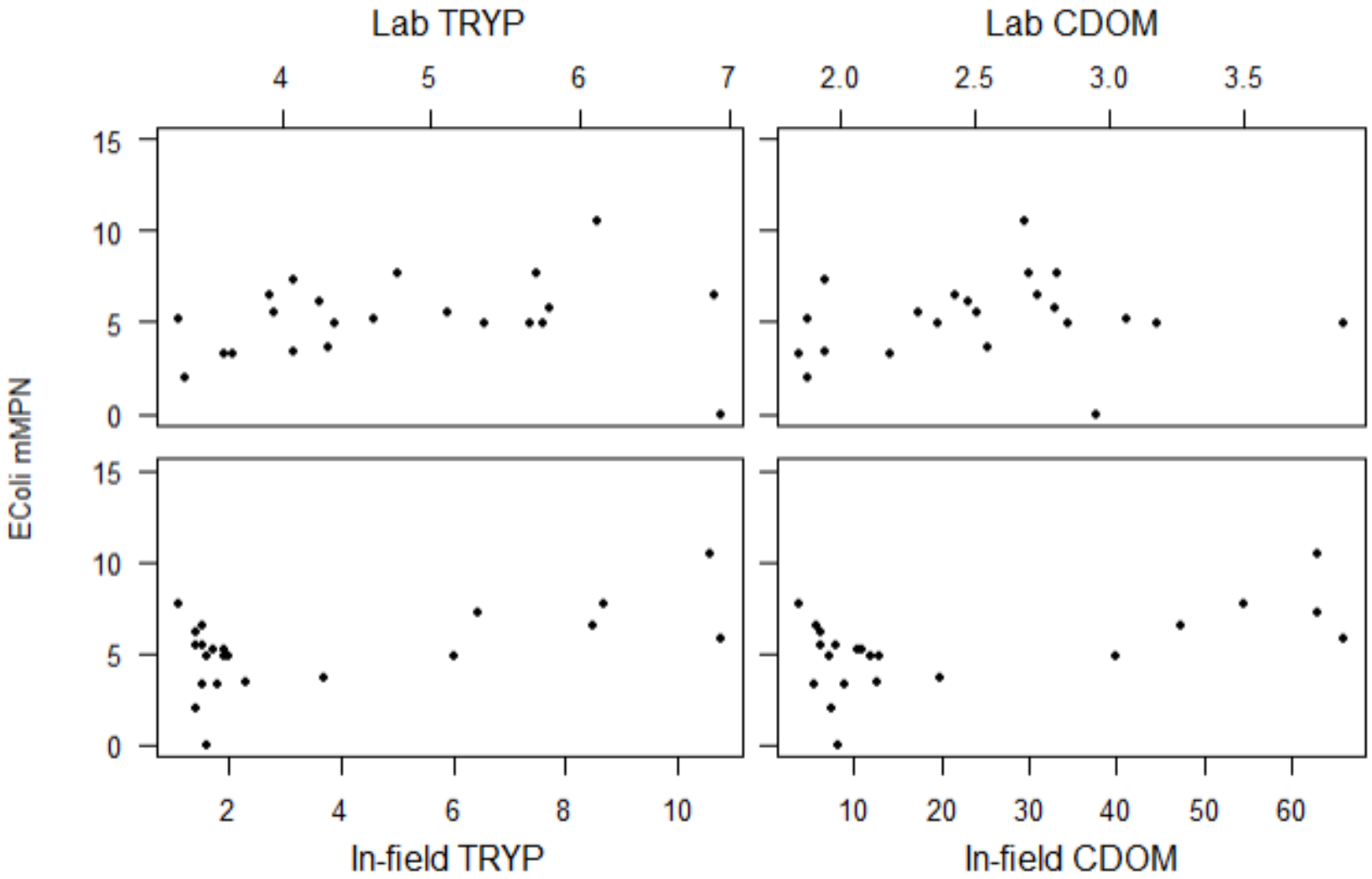
Methods: In situ sensors (Manta 3)



Lab instrument correlates better with bacteria than field-based….



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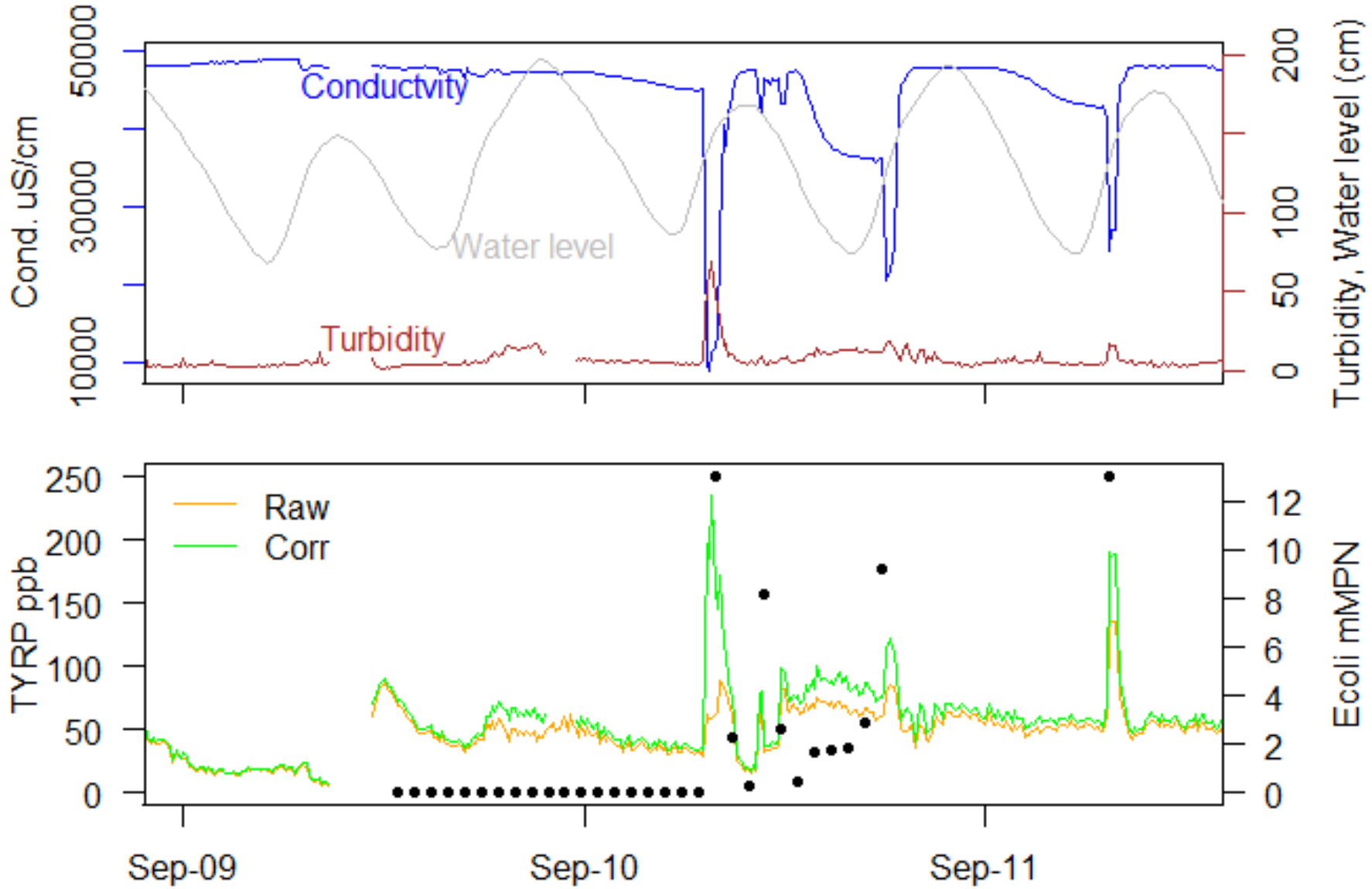
Sept 2022 Storm Event



Boca Rio site (estuary)
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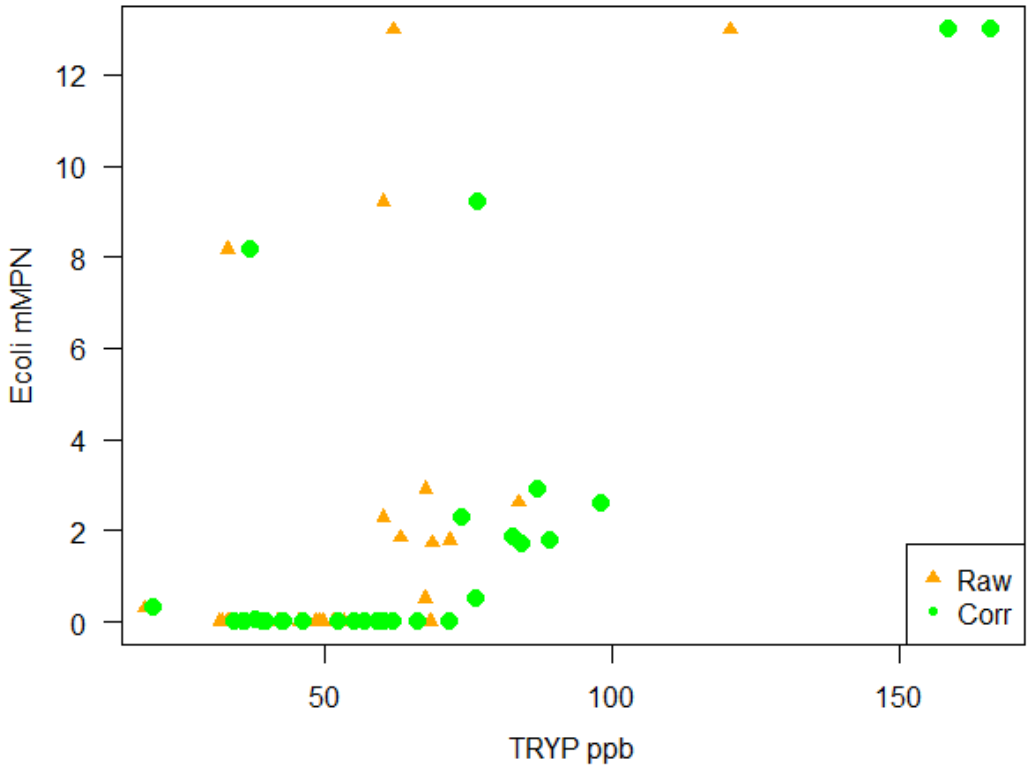
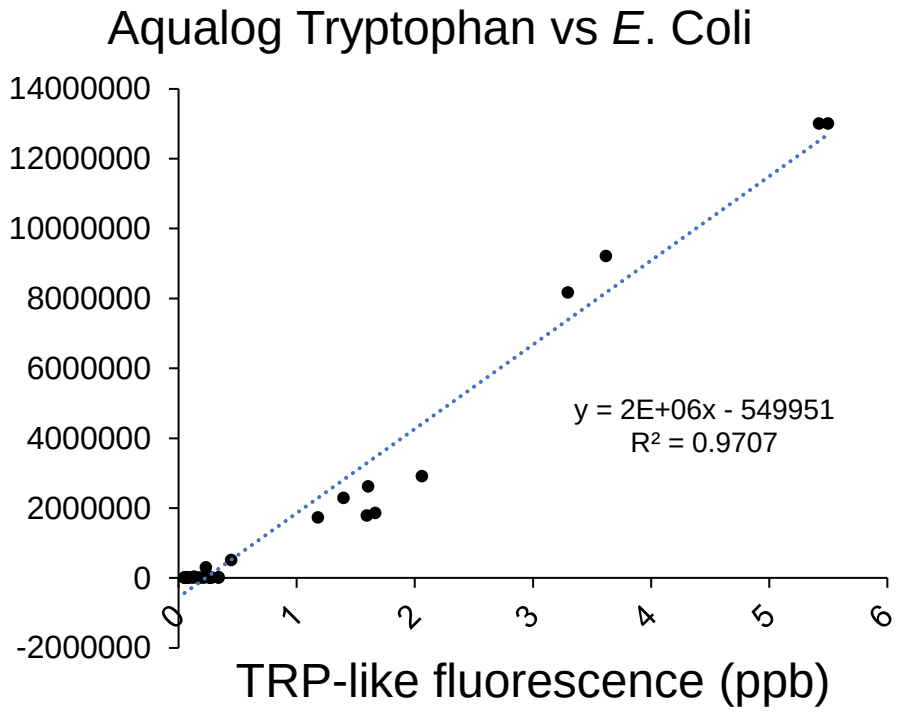
In-field TRYP: Pretty good



Lab TYRP on filtered sample: Great!



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